# The Kasimir Project: Knowledge Management in Cancerology

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The aim of the Kasimir project is the knowledge management for the cancer treatment, applied in the framework of the organisation of this treatment in Lorraine (a region of France). It gathers researchers in computer science[a] and in ergonomics[d], experts in cancerology[c] and an association federating physicians from Lorraine involved in cancerology[b].

## I. KASIMIR/RBR

For each cancer localisation, the treatment is based on a protocol. This protocol is built according to evidence-based medicine principles [1]. It is used literally for 70% of cancer cases. It can be seen as a set of rules whose premisses describe conditions on patients and whose conclusions are descriptions of treatments.

The system KASIMIR/RBR implements the protocol for breast cancers without metastasis. It proposes treatments thanks to rule-based reasonings (RBR). Its implementation uses an object-based representation and hierarchical classification (see, e.g. [2] and [3] respectively). The acquisition of the protocol representation –the KASIMIR/RBR knowledge base– has been based on the protocol written on paper sheets (which is the traditional tool to help physicians in their decision-making) and on the help of experts to make the knowledge explicit and non-ambiguous. Figure 1 shows an extract from the hierarchy of the treatments (which are primitive concepts in KASIMIR/RBR knowledge base).

KASIMIR/RBR development is based on genericity: the knowledge base and the specification of the interface are described in XML files. So, the adaptation of this system for other cancer localisations is quite simple, from an implementation viewpoint. A version for the prostate cancer has already been developed.

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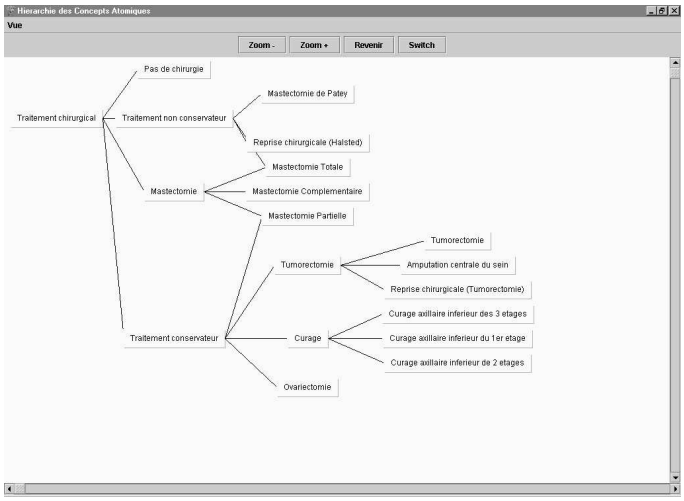


Fig. 1. A part of the KASIMIR/RBR knowledge base.

A future work aims at making this system operational for physicians of ONCOLOR. A validation study of KASIMIR/RBR has already been carried out. The aim of this study was to see whether the use of this system would involve an improvement in health care quality. A sample of 30 physicians of ONCOLOR had to propose treatments for patients with the help of the protocol written on paper sheets and/or with the help of KASIMIR/RBR. A statistically significant improvement of health care quality thanks to KASIMIR/RBR was shown.

An evolution of KASIMIR/RBR to a knowledge server according to the semantic web principles [4] (access to the informations by their contents) is under study.

Figure 2 shows a session of KASIMIR/RBR.

## II. KASIMIR/CBR

For the "out of the protocol" cases (30% of the cases), cancerologists try to *adapt* the protocol during the meetings of the so-called breast therapeutic decision committee (BTDC) that gathers some experts of the domains linked with breast cancerology (e.g., chemotherapy, radiotherapy and surgery). A case is "out of the protocol" if either the protocol does not provide a complete answer or the solution proposed by the protocol raises some difficulties (contraindication, impossibility of applying completely a treatment, etc.).

In this context, the development of the system KASI-

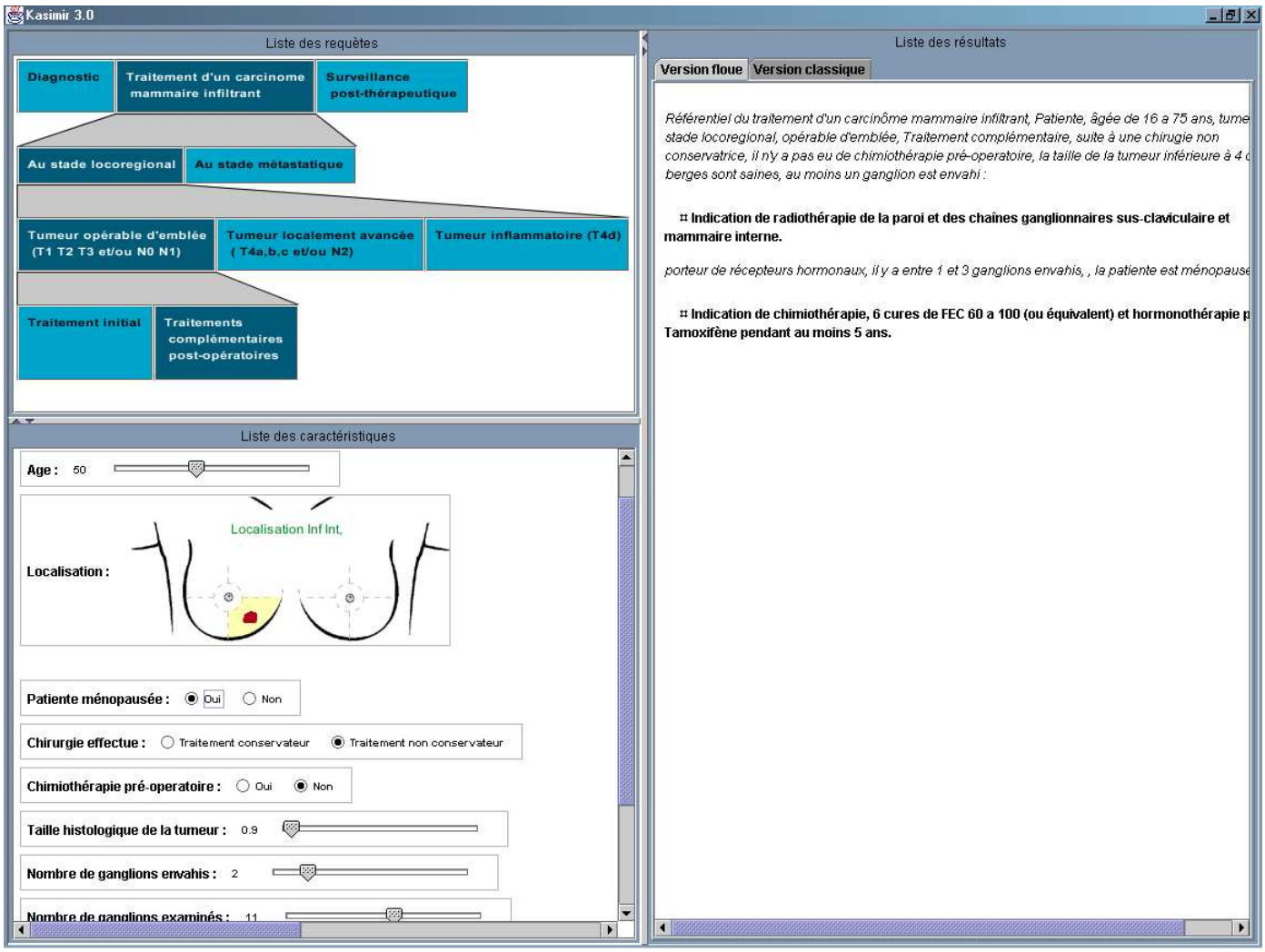


Fig. 2. A session of KASIMIR/RBR. On the left part: acquisition of the problem (on the bottom, acquisition of the current patient characteristics and, on the top, acquisition of the question raised about this patient). On the right part: detailed description of a solution.

MIR/CBR is planned [5]. This system will be based on case-based reasoning principles (CBR [6]): it will select a rule and adapt the treatment associated with this rule in order to suggest a treatment for the current patient.

The conception of KASIMIR/CBR is a work in progress. A knowledge acquisition and modelling work needed for this system has been realised [7]. It is based on discussions with the experts about summaries of the BTDC meetings. It has shown several types of adaptation actually performed during BTDC meetings. For example, adaptation based on the available knowledge about therapeutic index is useful in particular to take into account contraindications (this index is the ratio of therapeutic benefits and negative effects of a treatment for a patient). The use of the so-called caution principle ("When one does not know, one should do as in the worst situation.") is used when crucial informations about the patient are missing. This study has finally shown the need to take into account the imprecision of the thresholds used for the decision for the size of the tumour, the age of the patient, etc. (threshold effect). A first version of KASIMIR/CBR has been implemented which addresses the threshold effect issue thanks to a fuzzy hierarchical classification [8]: when a characteristic of the patient is in the fuzzy zone around a threshold, the two treatment alternatives corresponding to "under" or "above" the threshold are proposed to the user. Figure 3 shows a session of this first version of KASIMIR/CBR.

These adaptation schemas involve some new needs in knowledge representation: the problems, the solutions and the links between them have to be made more precise, and the adaptation operators have to be represented. Answering these needs is a work in progress.

## III. Protocol Evolution Suggestions

The adaptations can be used to propose evolutions of the protocol thanks to its confrontation with real cases. The idea is then to make some protocol evolution suggestions based on frequently performed adaptations. This has been studied from an ergonomic viewpoint [9]. Studying how a computer system could make such suggestions is a future work.

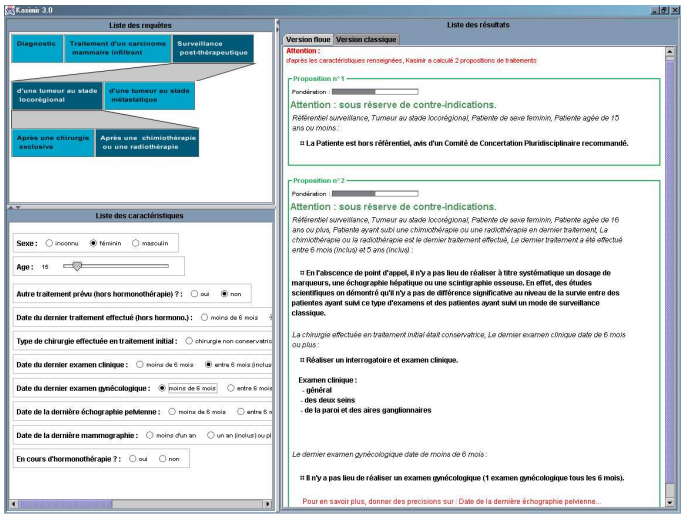


Fig. 3. A session of the first version of KASIMIR/CBR, based only on fuzzy classification. On the right, two treatment propositions are described.

## IV. Discussion and Conclusion

KASIMIR/RBR can be compared to ONCODOC which is an implementation of a clinical guideline for breast cancer treatment [10]. Like KASIMIR/RBR, ONCODOC provides therapeutic propositions. Among the differences between the two approaches, it can be noticed that ONCODOC is a documentary system enabling to navigate in a clinical guideline by following hypertext links whereas KASIMIR/RBR is a knowledge-based system based on an object-based representation. The consequence of this is that the reasoning engine and the knowledge base of KASIMIR/RBR are separated and can evolve independently one from the other. This means in particular that the introduction of new representations and new reasonings are facilitated in KASIMIR/RBR.

The original approach of knowledge management of the Kasimir project is based on the confrontation of the cases with the knowledge base: the latter must sometimes be adapted to the formers, and these adaptations may involve evolutions of the knowledge base. From a general viewpoint, the Kasimir project aims at building a knowledge management system since, according to [11], it will be useful (1) to capitalise the available knowledge, (2) to share this knowledge in order to improve the efficiency of the organisation and (3) to the creation of new pieces of knowledge. The issue (1) is realised, thanks to KASIMIR/RBR. The evolution of KASIMIR/RBR to a knowledge server will answer the issue (2). Finally, the issue (3) will be based on protocol adaptations and protocol evolutions, as described in sections II and III.

Much work remains to be done in the Kasimir project. From a development viewpoint, an extension of KASIMIR/RBR to other cancer localisations and other types of decision problems in cancerology (e.g., diagnosis) is planned. Furthermore, its evolution as a knowledge server will make it easier to use for distant users. KASIMIR/CBR is still under conception. Works to be done are continuation of the adaptation knowledge acquisition, representation of knowledge linked with adaptation and implementation of an adaptation engine (based in particular on the fuzzy and smooth classification algorithms described in [8]). Finally, if the research about protocol evolution is well-advanced from an ergonomic viewpoint, almost everything has to be done for it from a computer science viewpoint.

## References


[1] C. Sauvagnac, J. Stines, A. Lesur, P. Falzon, and P. Bey, "Application of therapeutic protocols: a tool to manage medical knowledge," in *Proceedings of the Joint European Conference on Artificial Intellingence in Medicine and Medical Decision Making (AIMDM-99)*, W. Horn, Y. Shahar, G. Lindberg, S. Andreassen, and J. Wyatt, Eds., Berlin, 1999, vol. 1620 of *LNAI*, Springer.

[2] A. Napoli, C. Laurenço, and R. Ducournau, "An object-based representation system for organic synthesis planning," *International Journal of Human-Computer Studies*, vol. 41, no. 1/2, pp. 5–32, 1994.

[3] F. Baader, B. Hollunder, B. Nebel, and H.-J. Profitlich, "An Empirical Analysis of Optimization Techniques for Terminological Representation Systems," in *Proceedings of the third International Conference on Principles of Knowledge Representation and Reasoning (KR'92), Cambridge, Massachussetts*, 1992, pp. 270–281.

[4] T. Berners-Lee, J. Hendler, and O. Lassila, "The Semantic Web," *Scientific American*, may 2001.

[5] J. Lieber and B. Bresson, "Case-Based Reasoning for Breast Cancer Treatment Decision Helping," in *Advances in Case-Based Reasoning — Proceedings of the fifth European Workshop on Case-Based Reasoning (EWCBR-2k)*, E. Blanzieri and L. Portinale, Eds., Lecture Notes in Artificial Intelligence 1898, pp. 173–185. Springer, 2000.

[6] C. K. Riesbeck and R. C. Schank, *Inside Case-Based Reasoning*, Lawrence Erlbaum Associates, Inc., Hillsdale, New Jersey, 1989.

[7] J. Lieber, P. Bey, F. Boisson, B. Bresson, P. Falzon, A. Lesur, A. Napoli, M. Rios, and C. Sauvagnac, "Acquisition et modélisation de connaissances d'adaptation, une étude pour le traitement du cancer du sein," in *Actes des journées ingénierie des connaissances (IC-2001)*, Grenoble, 2001, pp. 409–426.

[8] J. Lieber, "Strong, Fuzzy and Smooth Hierarchical Classification for Case-Based Problem Solving," in *accepted for publication in the proceedings of the 15th European Conference on Artificial Intelligence (ECAI-02), Lyon, France*, F. van Harmelen, Ed. 2002, IOS Press, Amsterdam.

[9] C. Sauvagnac, *La construction de connaissances par l'utilisation et la conception de procédures. Contribution au cadre théorique des activités métafonctionnelles*, Thèse d'Université, Conservatoire National des Arts et Métiers, 2000.

[10] B. Séroussi, J. Bouaud, and É.-C. Antoine, "ONCODOC: a successful experiment of computer-supported guideline development and implementation in the treatment of breast cancer," *Artificial Intelligence in Medicine*, vol. 22, pp. 43–64, 2001.

[11] M. Zacklad, "Ingénierie des connaissances appliquée aux systèmes d'information pour la coopération et la gestion des connaissances," Habilitation à diriger les recherches en informatique de l'Université de Troyes, 1998.